



Contribution ID: 30

Type: **Talk**

Detection of Radio Signals from Cosmic Rays Using Convolutional Neural Networks with Data from SKALA antennas at IceTop

Wednesday, 29 January 2025 11:20 (20 minutes)

Cosmic rays colliding with atmospheric particles produce cascades of secondary particles known as extensive air showers. These showers emit electromagnetic radiation whose radio component is detectable by radio antennas. At the surface of the IceCube Neutrino Observatory in Antarctica, a prototype station equipped with three antennas has been collecting background and air-shower data since 2020. Traditionally, we have employed Signal-to-Noise Ratio (SNR) cuts to select candidate radio events, which discarded valuable measurements of air showers at lower SNR levels. However, Convolutional Neural Networks (CNNs) can outperform traditional methods in classification and denoising radio pulses from air showers. Such CNNs have been trained on the waveforms resulting from combining South Pole background data with simulated cosmic-ray signals generated by the CoREAS software. The CNNs can identify additional air-shower events that do not pass traditional SNR cuts, while also improving the accuracy of pulse power and timing measurements. Recently, we have also started to explore the impact of upsampled waveforms on the accuracy of CNN-based classifiers and denoisers. These networks will contribute to achieving the science goals envisioned for radio arrays for air-shower detection, such as the IceCube-Gen2 Surface Array.

Type of Contribution

talk

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Session Classification: Talks